# FIRST RECORD OF THE BASE-BORER WEEVIL, *SPARGANOBASIS SUBCRUCIATA* MARSHALL (COLEOPTERA: CURCULIONIDAE: DRYOPTHORINAE), FROM OIL PALM (*ELAEIS GUINEENSIS* JACQ.) IN PAPUA NEW GUINEA AND ITS ASSOCIATION WITH DECAYING STEM TISSUE

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## Abstract

The native base-borer weevil, *Sparganobasis subcruciata* Marshall, is recorded for the first time from tissues of cultivated oil palm (*Elaeis guineensis* Jacq.) in Papua New Guinea. Adults, larvae, pupae and damage are illustrated. Evidence suggests that attack is initiated by odours produced by fungal decay of palm tissues caused by *Ganoderma boninense* Pat. and secondary decomposers or by *Thielaviopsis paradoxa* (de Seynes) in oil palm frond axils.

## Introduction

In September 2010, the Technical Services Division (TSD) at Higaturu (New Britain Palm Oil, Northern (Oro) Province, Papua New Guinea (PNG), reported that oil palms suspected of being attacked by the fungus *Ganoderma boninense* Pat. were also infested by insect larvae. The oil palms were growing at Mamba Estate, a plantation of mature oil palms planted at high densities (143 palms/ha) and located in the Mamba Valley, on the northern side of the Kumusi River, at an elevation of about 384 m. The palms affected were approximately 22 years old and were due for felling before replanting was undertaken.

Specimens were sent to specialists in the United Kingdom and Australia, where they were identified as *Sparganobasis subcruciata* Marshall by C. Lyal (Natural History Museum, London) and R. Oberprieler (CSIRO, Canberra), a weevil that appears to be endemic to the island of New Guinea and known as the base-borer weevil (Froggatt 1936). It was originally described from three specimens collected at the Utakwa River in the Sudirman (Snow) Mountains in 'SW Papua' (Irian Jaya, now West Papua). A further four specimens (3 ♂♂, 1 ♀) were from Andai [South of Manokwari, Doberai Peninsula] and Sele [NW Birdshead Peninsula] in the former Dutch New Guinea (now West Papua) and Batchian and Misol Islands in the Moluccas (Maluku) (all now part of Indonesia). They are housed in the Pascoe collection in the Natural History Museum, London (Marshall 1915).

*Sparganobasis subcruciata* was first reported as a pest of coconut palms by Simmonds (1925) in Madang Province of mainland PNG, where the feeding activity of the weevils eventually caused the coconut palms to collapse. The first documented record of this weevil from cultivated plantation oil palms (*Elaeis guineensis* Jacq.) is provided here.

Voucher specimens collected at Mamba Estate are deposited in the PNGOPRA reference collection, the National Insect Collection (NIC) in Port Moresby, Papua New Guinea and CSIRO in Canberra, Australia. Specimens are illustrated on the Museum Victoria Pests and Diseases Image Library (PaDIL) website.

## Morphology and biology

Adults of *S. subcruciata* are variable in size, with a mean length of 21 mm. Without the rostrum, both sexes are about 16.5 mm long (n = 12), males averaging 15.5 mm and females 17.5 mm. When palm trunks were cut open, all except the egg stage of *S. subcruciata* were found, with many of the adults in a teneral condition (recently eclosed from the pupal cell), paler in colour but with a more clearly defined dorsal pattern. Adults are also variable in colour and intensity, varying from reddish with paler markings to black with little obvious markings on the elytra. Well marked adults may be recognised by the broad, pale markings on the pronotum and the broad, pale diagonal bands converging at the centre line of each elytron, contrasting against the darker background (Fig. 1).

The elytra are oblong-ovate and broadest at the shoulders, with raised longitudinal carinae. The lateral edges of the abdomen, legs and rostrum are densely covered with small punctures (punctate), clearly visible in lateral view (Fig. 2). These markings are much less obvious on darker specimens, except when viewed through a 10x hand lens. The prothorax is longer than broad and the head and prothorax are densely covered with circular, pale punctures. The wings are sooty-coloured and well developed (Fig. 3).

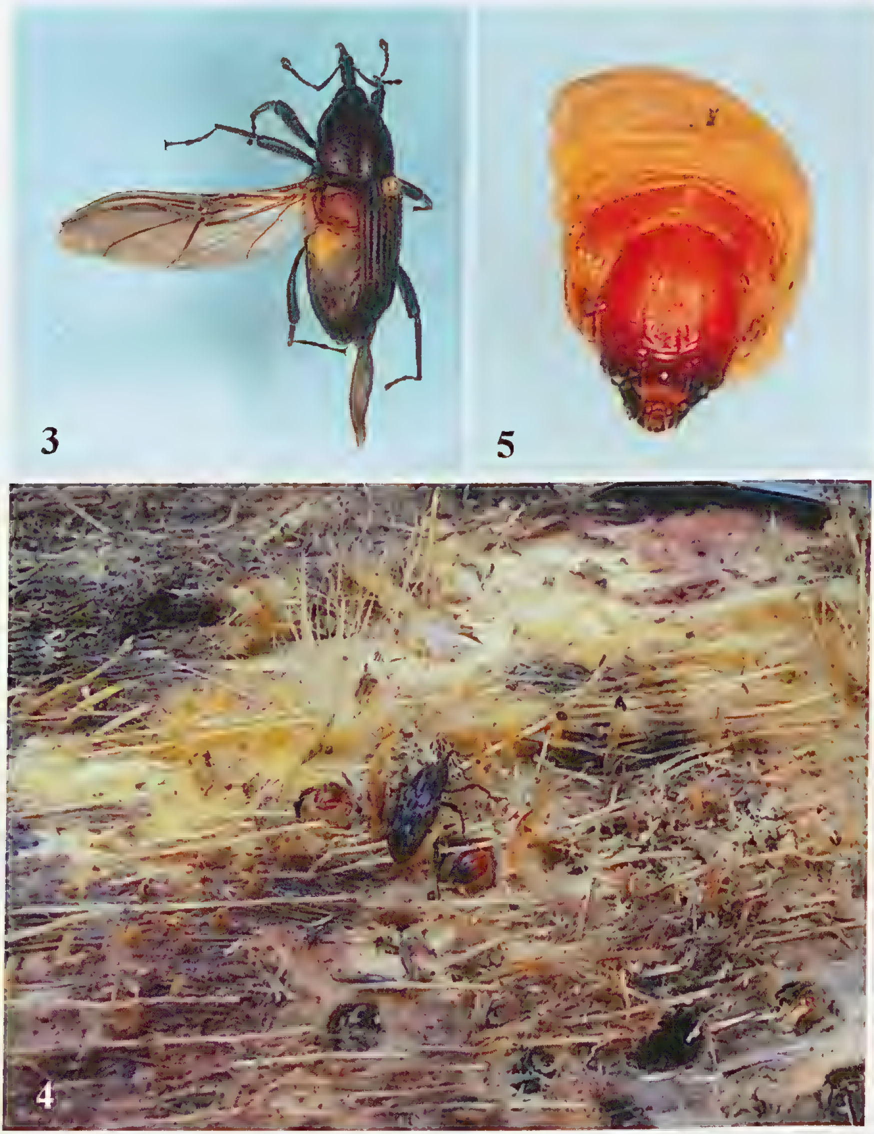
The female has a more obviously curved rostrum than the male and its basal part is covered with larger punctures. The distal part lacks punctures, while the rostrum of the male has similar, smaller punctures throughout its entire length. The legs are black and pustulate and the tibiae possess sharp terminal spines that enable the beetle to retain a firm grip on the substrate (Marshall 1915). Males are smaller than females and the sexes may also be distinguished by differences at the distal part of the abdomen, which in ventral view is wavy in outline and slightly angular in males but dull and rounded in females (R. Oberprieler pers. comm.).

Although fully winged, *S. subcruciata* adults were not observed to fly during the day and are probably crepuscular or nocturnal, as was reported by Froggatt (1936) for the banana weevil, *Cosmopolites sordidus* Chevrolat, in Australia.

Two samples of *S. subcruciata* adults (70 in total) from Mamba Plantation yielded 28 males and 42 females (sex ratio 1:1.5). Adults were also recently collected by one of us (CP, in 2011) from *G. boninense* infected oil palm at Milne Bay Estates, Milne Bay Province, Papua New Guinea.

**Figs 1-2.** *Sparganobasis subcruciata.* (1) dorsal views of adult male and female; (2) lateral view of adult male. Photos: Bill Page, PNGOPRA.

Larvae, pupae and adults were collected from the Mamba Estate plantation in September and November 2010. Immature stages were abundant among the tissues of the lower part of the trunk up to about 2 m above the ground and were concentrated in the outer tissues of the trunk beneath bark (Fig. 4).



**Figs 3-5.** *Sparganobasis subcruciata*. (3) adult showing extended wing; (4) larvae *in situ* beneath bark; (5) larval head capsule. Photos 3 & 5: Bill Page (PNGOPRA).

Larvae of *S. subcruciata* are apodous, clearly segmented and with a noticeably setose, chestnut-brown head capsule with an inverted Y-shaped epicranial suture on the frons, between the arms of which is a raised area with two large, lateral pits (Fig. 5). They are similar to, although smaller than, those of the cane weevil borer, *Rhabdoscelus obscurus* (Boisduval), adults of which are commonly found on freshly cut frond bases together with other species of Dryopthoridae such as the lesser coconut weevil, *Diocalandra frumenti* (Fabricius) (Fig. 6). Once removed from palm wood, the larvae of *S. subcruciata* are immobile except for the rhythmic pulsations of the entire body.

*Sparganobasis subcruciata* larvae were found among the outer tissues of the trunk, below the fibrous outer layer, with evidence (from a larva found with rot tissue) that they entered from the frond basal area, where organic detritus collects. Lever (1969) similarly reported larvae of *S. subcruciata* tunnelling into the trunk of a coconut palm, from 'the point of junction of a leaf petiole'. Larvae live in well defined tunnels among the pale living tissue; however, no larvae were collected from dead, dark brown palm trunk tissue. From one collapsed and rotten palm, larvae and cocoons of the much larger black palm weevil, *Rhynchophorus bilineatus* Montrouzier, were also found.

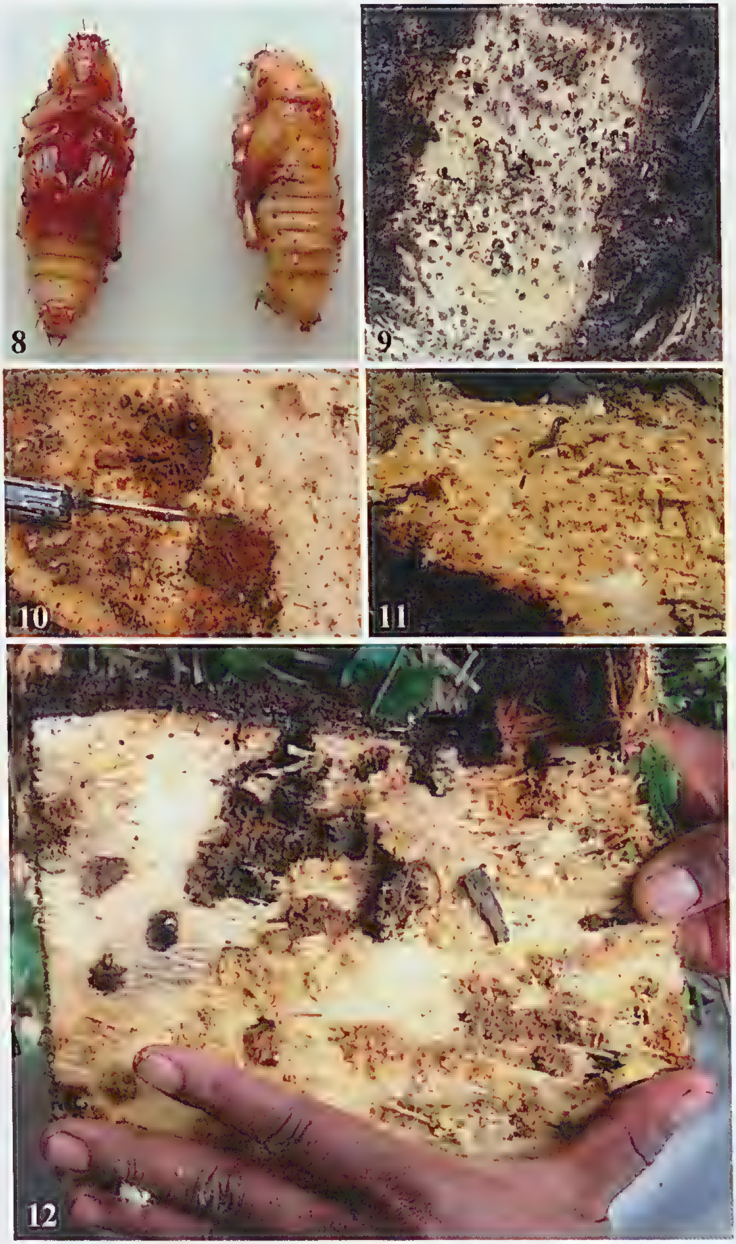
Pupal cells, made from chewed palm wood tissue and lined with a smooth, light brown coating, were found in the larval tunnel. The head of the pupa was orientated towards the outside of the palm and the tunnel was plugged with palm fibre, permitting the emerging beetle to exit to the exterior of the palm (Fig. 7). The pupa is *ca* 21 mm long, pale cream in colour and sparsely spinose, particularly at both anterior and posterior ends. Pupae were very active when disturbed, making vigorous circular movements of the abdominal segments that caused them to rotate rapidly in the cell (Fig. 8). Pupae become darker as they near eclosion.

External evidence for the presence of the weevil was not obvious; however, close inspection of the palms, especially those that lacked old frond bases (*i.e.* with the trunk quite smooth), revealed signs of weevil presence in the form of small patches of oozing sap and sawdust from circular depressions, often plugged with vascular tissue, indicating the exit holes (Fig. 9), a feature also observed by Lever (1969).

**Attraction to rotting wood:**

As all but one of the *S. subcruciata* samples were collected from palms that had been attacked by the fungus *G. boninense*, the presence of an attractant was assumed. The nature of the attractant odour(s) is unclear. Odours are produced by both *T. paradoxa* and additional invasive organisms that cause a secondary, 'soft rot', which is commonly seen in *G. boninense*-infected palms in advanced stages of the disease.


**Figs 6-7.** (6) adults of *Rhabdoscelus obscurus* and *Diocalandra frumenti* on oil palm cut frond base. (7) larva of *Sparganobasis subcruciata* in tunnel in oil palm trunk, with head to left.




**Figs 8-12.** (8) pupae of *S. subcruciata*, ventral and lateral views. (9) cut bark showing exit holes. (10) two round rot patches. (11) dead palm tissue with many larvae and a banded millipede. (12) section of outer bark removed to show damage penetration.

A simple attraction trial was carried out at Mamba Estate. Ten adult weevils were placed at the centre of a large (52 cm diameter), blue plastic bowl and two small pieces of either fresh oil palm wood fragments or fragments with 'rotted' wood were added at opposite sides. They were left undisturbed overnight. The following morning, nine weevils had moved to the 'rotted' tissues and a single beetle remained at the centre of the bowl.

Since the fungus *T. paradoxa* was isolated from wood tissue in which larval tunnels of *S. subcruciata* were found, a similar experiment using *T. paradoxa*-inoculated oil palm wood and four weevils collected in Milne Bay Province was undertaken, with similar results. Interestingly, the rotting frond bases from which larval tunnels originated showed clear evidence of a wet rot that might have been caused by the fungus *T. paradoxa*, as indicated by the coloration and odour of the tissue. Species of the teleomorph *Ceratocystis* produce volatile compounds (Hanssen 1993), which might be attractants for *S. subcruciata*. We believe that odours that are produced during the breakdown of the oil palm tissues by secondary invasion of other micro-organisms (*e.g.* yeasts or bacteria) might also be involved in attracting the weevils. It is not clear which of these odours is the primary attractant.

**Damage**

Fig. 10 shows a rot, possibly initiated by *T. paradoxa* that is often found in association with decay by *G. boninense*. As the development of an infestation of weevil larvae progresses, damage to the vascular tissue may become almost total (Fig. 11). In three palms where larvae were found, their trunks had snapped and the palms had collapsed. Close inspection after crude dissection of one of these palms confirmed that the infestation was caused by larvae of *S. subcruciata*.

Numbers of a brightly coloured banded millipede (Family Platyrhacidae: H Enghoff *in litt.*) were found on the exposed and decaying tissues of collapsed and broken palm trunks assisting with the breakdown process.

Nine palms with signs of infection by *G. boninense* ('suspect palms') and two palms that showed no outward signs of infection were felled and crudely dissected. The 'suspect palms' contained varying levels of weevil infestation, with adults, larvae and pupae present in the tissues. One of the latter two palms also contained *S. subcruciata* larvae in tissues near its periphery; the other did not contain larvae. Damage was concentrated in the lower part of the palm, to a height of about 2 m above the root base. Also examined was palm tissue that had been cut out of one host palm in July 2010 (4 months previously); although dry and friable, the tissues were still largely intact and no larvae, pupae or adult weevils were found.

Larval damage to the tissues spread from the outer tissues towards the centre of the palm (Fig.12). Heavy infestations were detectable by the presence of emergence holes and holes blocked with vascular tissues that are readily visible, being particularly obvious when the outer bark tissue is removed.

**Monitoring and control**

Larvae were heard feeding inside palms by Mamba Estate plantation workers on two occasions during these investigations. Sound production by the larvae of weevil species feeding within the trunk tissues was reported by Froggatt (1936) and was also investigated by Al-Manie and Alkanhal (2005) in Saudi Arabia, using ultra-sound recorders for larvae of *Rhynchophorus ferrugineus* (Olivier) in date palms (*Phoenix dactylifera* L.). A medical stethoscope was used at Mamba Estate, to listen for the larvae/pupae of *S. subcruciata*; however, the hirsute nature of the palm surface caused too much background interference and no definite sound of larval/pupal activity was detected.

As the weevil appears to be closely linked to the presence of what may now be called 'frond-base rot' (FBR) and *G. boninense*-induced rot, treating a palm to kill the weevils at this stage will be too late to save the infected palm. Once *G. boninense* is established in a palm, that palm will eventually die without fungicidal intervention.

One palm showing symptoms of a *G. boninense* infection was injected with 90ml of glyphosate [Roundup™] and killed. Four months later it was felled and although there was no sign of *G. boninense*, a thriving population of weevil larvae was found among the tissues, suggesting weevils as the cause. The injection of glyphosate did not appear to affect weevil development, at least while the tissues remained firm. There is currently no evidence to suggest that the weevil is a vector of *G. boninense* as the fungus was not isolated from any weevils subsequently screened.

There is no monitoring system presently available for this weevil; however, the following options should be investigated using traps to monitor adult populations: (1), using natural attractant material from *G. boninense* or *T. paradoxa* infected tissue, as indicated by the Milne Bay trial; (2), development of synthetic *S. subcruciata* attractants based on the above chemicals; (3), identification and synthesis of a pheromone produced by *S. subcruciata* for use in traps.

Options for the control of weevil larvae in *G. boninense*-infected palms include: (1), timely application of recommended control procedures for *G. boninense*-induced basal stem rot should prevent secondary rots from developing, thereby reducing the likelihood for attraction of *S. subcruciata*; (2), reducing palm planting densities will result in palms with shallower frond bases, (3), if infestations of either *G. boninense* or *S. subcruciata* are identified, then emerging adults, larvae and pupae may be killed by following PNGOPRA recommendations (Pilotti 2006) and spreading the chipped wood out to dry before burying the chips.

**Laboratory observations of larval and pupal weights**

One hundred and five larvae were collected from Mamba Estate in September 2010 and 27 live larvae were subsequently weighed in the laboratory (78 died in transit between Mamba Estate and PNGOPRA office at Higaturu). The mean weight of the live larvae was 0.81 g (sd = 0.22). Among them was a cohort of much lighter (younger) larvae, weighing between 0.2-0.3 g. (Fig. 13), indicating the development of a new generation.

A small sample of three pupae was also collected in September 2010, which had a mean weight of 0.64 g (sd = 0.12). This was almost double that of the 21 pupae collected in November 2010, which had a mean weight of 0.37 g (sd = 0.10).

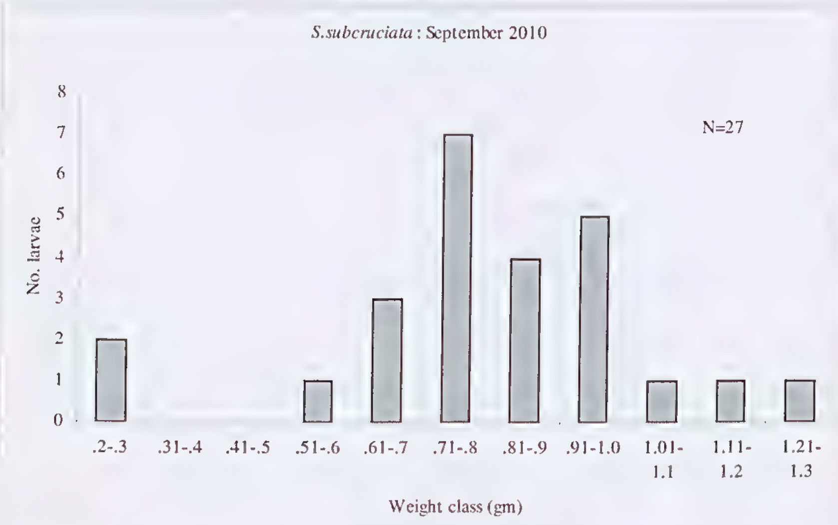



**Fig. 13.** Live weights of 27 *S. subcruciata* larvae collected at Mamba Estate in September 2010.

## Discussion

These observations suggest that *S. subcruciata* poses a potential threat to oil palms, especially in areas where high density planting and high rainfall results in long frond bases remaining on palms. These are typically produced in light-restricted valleys (W. Griffiths-NBPOL pers. comm.). In such high rainfall areas, organic matter and rainwater collect in the frond bases, which encourage the development of 'frond-base rot' and subsequent invasion by saprophytic fungi, including *T. paradoxa*. Chemical emissions from tissue breakdown caused by *T. paradoxa*, as well as other micro-organisms in the frond bases of oil palms, are the most probable sources of attractants for adult weevils. It is currently unknown if the initial attack by *S. subcruciata* was direct or was triggered by odours associated with *T. paradoxa* (as a result of the decay of wet organic detritus accumulating in the frond bases), *G. boninense* or a combination of factors.

Although the development cycle of *S. subcruciata* is still unclear, results indicate a clear temporal change in the phenology of larval populations, as younger (not measured) larvae were found in November 2010. Traps using natural or synthetic derivatives of the fungus *T. paradoxa*, or simply rotting *G. boninense*-infected wood, should be tested, while the possibility of extracting a pheromone from the weevils should also be investigated.

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